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EFFECT OF PROCESSING AND PREPARATION FOR SERVING ON VITAMIN CONTENT IN T, B, AND A RATION PEAS AND CARROTS

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BY

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The nutritional quality of T, B, and A Rations was compared using peas and carrots. A meat item (pork) had been studied previously. All three rations were subjected to various heating and holding procedures to simulate the military serving practices. Two most heat labile vitamins, ascorbic acid and thiamin, were chosen as sensitive indicators of change upon each treatment. For both T and B Rations, the retention of thiamin is about 40% after retorting and heating. Only minor changes occur during the subsequent serving practices. Little ascorbic acid remains after retorting and heating for both T and B Rations. It is concluded that T and B Ration peas and carrots are nutritionally equivalent as far as the retention of ascorbic acid and thiamin is concerned. They are lower in these vitamins than the nonprocessed A Ration. After cooking, A Ration peas and carrots retain 72% thiamin and 9% ascorbic acid.

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PREFACE

The present report is a sequel to the report "Effect of Processing and Preparation for Serving on Vitamin Content in T, B and A Ration Pork".[3] It was funded under the work unit "Effect of Preparation/Serving on the Nutritional Stability of Combat Rations", Project No. ILI62724AH99BA029. Miriam Thomas had been the project officer before she retired in March, 1985. The work was accomplished during the period April 1985 to September 1985.

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EFFECT OF PROCESSING AND PREPARATION FOR SERVING ON VITAMIN CONTENT IN T, B AND A RATION PEAS AND CARROTS

INTRODUCTION

In the early 1980's, a heat-sterilized, fully-prepared shelf stable Tray Pack (T Ration) was newly developed at the U. S. Army Natick Research and Development Center for combat field feeding. The T Ration was designed to provide hot meals to highly mobile tactical units, dispersed over a broad range of combat situations and locales.[1,2] Being a new product, the nutritional adequacy of Tray Pack foods had to be determined. A study was initiated to compare the nutritional quality of T Ration items with similar A and B Ration items. Although the A Ration is not functionally equivalent to the T Ration, the A Ration is included for comparative purposes, because it is generally believed that A Ration foods prepared from fresh or frozen material are more nutritious than processed foods. The first item, pork, was studied and reported by Thomas, Narayan and Atwood.[3] The results for the second item, peas and carrots, are reported in this work.

MATERIALS AND METHODS

A mixture of peas and carrots was selected for study because (1) it is common to all three (T, B and A) Rations; (2) it is a vegetable item (a meat item had been studied previously); and (3) it is reasonably high in thiamin and ascorbic acid, indicator nutrients which were chosen because of their sensitivity to heat and air during processing. Peas are a better source for both vitamins than carrots. However, peas are not processed as a single item in Tray Pack (TP), but are available as a mixture with carrots.

Frozen peas and frozen diced carrots were procured from Sexton, Inc., (Boston). Fresh peas and carrots are usually used for processing B Rations. However, at the time of the year when the study was initiated, it was difficult to obtain fresh peas. Thus for all three rations, frozen peas and frozen diced carrots were used to prepare the product as follows.

(1) The T Ration product was prepared according to the interim federal specification on peas and carrots.[4] Frozen peas and carrots (2:1 ratio) were packed into TP containers with added brine, sealed with a minimum of 10 inches vacuum and processed at 121°C. Twelve TPs out of a total 41 were equipped with one or two thermocouples. The retorting was done to achieve a minimum F_o value of 6 for the peas at the center of TP container. F_o value for 12 TPs ranged from 8.0 to 12.6.

(2) The B Ration product was prepared in accordance with the federal specification on vegetables[5] and the Code of Federal Regulations.[6] Frozen peas and frozen diced carrots were packed separately into No. 10, B Ration cans with added brine, sealed with less than 5 inches of vacuum, and processed at 121°C to a minimum F_o of 6. For peas, 12 out of 30 cans were fitted with thermocouples and F_o values ranged from 6.1 to 9.4. Ten out of 32 carrot cans had thermocouples and F_o values between 6.0 and 9.4. The No. 2-1/2 cans used in the pork study[3] were not utilized because peas and carrots are not available in that size.

(3) A Ration frozen peas and carrots were cooked as directed in Armed Forces Recipe Service: A mixture of frozen peas and carrots (2:1) was added to a pot of boiling salted water, brought to boil, simmered for 7 min and drained.[7]

After retorting, the No. 10 cans and TPs were held at room temperature for two weeks to test for swelling and then stored at 4°C until further treatment. They were removed from 4°C storage and left at room temperature overnight before being subjected to various military garrison and field feeding practices. TP peas and carrots were heated for serving in simmering water for 15 min. They were opened immediately, drained, and kept in the freezer for two hours at least before they were blended for vitamin assay. After heating, some TP cans were held unopened for 2 h in the insulated containers filled with boiling water (100°C). Others were opened, drained, and held over hot water (74°C) for 1 or 2 h.

A basically similar procedure was followed for B and A Rations, although the method of preparation varied depending on the ration. The instructions in Armed Forces Recipe Service[7] and Standard B Ration for the Armed Forces[8] were followed for A and B Rations. Although these instructions for the B Ration state two No. 10 cans of peas are mixed with two No. 10 cans of carrots to make 100 servings of peas and carrots, this ratio of peas to carrots was changed to 2:1 in this experiment to simulate both T and A Rations. B Ration peas and carrots were heated in a pot with just enough liquid brine from the cans of peas to cover, simmered for 10 min and drained. Some peas and carrots were transferred to metal inserts in the insulated containers filled with boiling water. Others were held in bain marie. The detailed experimental plans are in Table 1.

As the severest treatment for A Ration, peas and carrots were cooked, drained, and held in bain marie for 2 hours, refrigerated overnight and reheated before vitamin analysis. The refrigeration study was not included for T and B Rations since they are only used where there is no refrigeration facility. An additional treatment for TPs was to cool heated TPs at room temperature and to reheat before analysis. The cooling and reheating cycle was repeated once more to simulate the worst case in the field when all the reheated TPs are not used and the remaining ones are reheated once more before consumption.

Peas and carrots treated according to the plan were cooled in the freezer at least for 2 h before they were blended in the Robot Coupe R2 commercial food processor. Ascorbic acid was analyzed within two hours after blending and the remaining samples were frozen until analyses for

TABLE 1. Experimental Plan

Tray Pack

STEPS	PROCEDURE
(1)	Frozen peas and frozen diced carrots mixed (2:1)
(2)	TP containing 2000 g peas and carrots and 1000 g brine sealed and commercially sterilized to a minimum F_o of 6
(3)	TP heated for 15 minutes unopened, immersed in simmering water in steam jacketed kettle
(4)	Same as (3), completely cooled to room temperature, then reheated for 15 minutes in simmering water
(5)	Same as (4), completely cooled, reheated for 15 minutes in simmering water
(6)	Same as (3), unopened TP held for 2 h in insulated container filled with boiling water (100°C)
(7)	Same as (3), opened, drained, held over 74°C water for 1 hour
(8)	Same as (7), held for 2 hours

B RATION

(1)	Frozen peas and carrots unmixed
(2)	Commercially sterilized in No. 10 cans (each can contained 1800 g peas and 1300 g brine or 1600 g carrots and 1150 g brine)
(3)	Mixed 800 g peas and 400 g carrots from each No. 10 can in Step (2)
(4)	Heated peas and carrots with 0.5 L brine from pea can in a pot and simmered for 10 minutes
(5)	Same as (4), drained and held in insulated container for 2 hours
(6)	Same as (4), drained and held in open bain marie over hot water (74°C) for 1 hour
(7)	Same as (6), held for 2 hours

TABLE 1. continued

A RATION

STEP	PROCEDURE
(1)	Frozen peas and frozen diced carrots mixed (2:1)
(2)	Added 1350 g peas and carrots into a pot of boiling salted water (0.95 L), heated to boil and simmered for 7 minutes
(3)	Same as (2), drained and held in insulated container for 2 hours
(4)	Same as (2), drained and held in bain marie for 1 hour
(5)	Same as (4), held for 2 hours
(6)	Same as (5), refrigerated overnight, reheated and drained (reheating was done by adding peas and carrots into a pot of boiling salted water, heating to boil and simmering for 1 min)

moisture and thiamin. A single analysis was made for moisture according to the A.O.A.C. Official Methods of Analysis.[9] Thiamin was measured in duplicate by the methods described in Methods of Vitamin Assay.[10] For ascorbic acid determination, duplicate samples of blended peas and carrots (5.0 g) were transferred into tubes containing 30 mL of 20 mM H_2SO_4 solution, homogenized with Polytron (Brinkmann Instrument) for 1 min, filtered through Millex-GV 0.22 μm filter unit (Millipore). The filtrate was analyzed using Wescan ion chromatography System with Wescan anion exclusion column. Typical conditions were: flow rate 1.5 mL/min; pressure 2000 psi; eluent 10 mM H_2SO_4; retention time 4.3 min. Ascorbic acid was detected by UV set at 260 nm. It was later found that HPLC peaks for ascorbic acid contained other compounds which were detected by UV but not by electrochemical detector. The impurity corresponds to about 6% of total ascorbic acid in frozen peas and carrots and was present in both frozen and processed samples. Ascorbic acid content for the samples was corrected for the impurity. Samples analyzed by both HPLC and the more widely accepted photometric method using 2,6-dichlorophenolindophenol,[5] showed similar results. Vitamin content is reported on a dry weight basis.

Five replicates were analyzed for most T, B and A Ration products, and their means were compared. Less than three replicates were used for ascorbic acid determination in B Ration.

RESULTS AND DISCUSSION

The effect of processing and serving practices for T, B and A Ration peas and carrots on thiamin and ascorbic acid content was evaluated according to the experimental plan in Table 1. The average thiamin and ascorbic acid content of peas and carrots after each treatment is given in Table 2. Some of these data are expressed as percent retention in Table 3.

Thiamin and ascorbic acid were chosen as indicator nutrients because they are known to be most sensitive to cooking and/or heat processing. Tables 2 and 3 show that the destruction of ascorbic acid is greater than that of thiamin regardless of the treatment. The greatest destruction of thiamin takes place during retorting (T, B Rations) and cooking (A Ration). Military serving practices had minimal effect on retention of thiamin in peas and carrots. Almost all ascorbic acid disappears after retorting and heating for T and B Rations. Cooked peas and carrots (A Ration) retain some ascorbic acid, which disappears rapidly upon holding.

Effect of retorting and cooking

As stated above, thermocouples were inserted to about one third of TPs and B Ration cans to follow the heat treatment at the slowest heating points of the cans. F_o values, the equivalent of all lethal heat, in minutes at 121°C, were calculated from the time-temperature history with respect to an organism with z value of 18.

TABLE 2. Effect of Preparation and Serving on Thiamin and Ascorbic Acid Content

a. Tray Pack Peas and Carrots (flat cans)

		Vitamins*	
		Thiamin	Ascorbic Acid
Treatment**		mg/100 g	mg/100 g
STEPS	PROCEDURE		
(1)	Frozen peas and carrots	1.52 ± 0.10***	78.2 ± 8.9
(2)	Retorted	0.66 ± 0.08	21.9 ± 2.7
(3)	Heated	0.56 ± 0.04	0.8
(4)	Heated twice	0.59 ± 0.03	0.6
(5)	Heated three times	0.55 ± 0.04	0
(6)	Held in insulated container	0.53 ± 0.02	0.7
(7)	Held in bain marie (1 h)	0.48 ± 0.03	0
(8)	Held in bain marie (2 h)	0.54 ± 0.04	0

*Vitamin content on a dry weight basis.

**See Table 1 for details.

***Standard deviation.

TABLE 2. continued

b. B Ration Peas and Carrots (cylindrical cans)

No. 10 cans		Vitamins	
		Thiamin	Ascorbic Acid
Treatment		mg/100 g	mg/100 g
STEP	PROCEDURE		
(1)	Frozen peas and carrots	1.52 ± 0.10	78.2 ± 8.9
(3)	Retorted	0.64 ± 0.06	25.3 ± 3.1
(4)	Heated	0.60 ± 0.09	0.6
(5)	Held in insulated container	0.62 ± 0.06	0
(6)	Held on bain marie (1 h)	0.65 ± 0.09	0
(7)	Held on bain marie (2 h)	0.71 ± 0.03	0

c. A Ration Peas and Carrots

(1)	Frozen peas and carrots	1.52 ± 0.10	78.2 ± 8.9
(2)	Cooked	1.09 ± 0.05	6.8 ± 1.4
(3)	Held in insulated container	1.00 ± 0.08	0.9
(4)	Held on bain marie (1 h)	1.07 ± 0.05	3.6
(5)	Held on bain marie (2 h)	0.97 ± 0.06	1.7
(6)	Refrigerated and reheated	0.80 ± 0.01	0

TABLE 3. Effect of Various Treatments on Vitamin Retention (%)* in Peas & Carrots

TREATMENT**	VITAMIN	RATIONS T	B	A
Retorted	Thiamin	43	42	-
	Ascorbic Acid	28	32	-
Cooked or heated	Thiamin	37	39	72
	Ascorbic Acid	1	1	9
Insulated container (2 h)	Thiamin	35	41	66
	Ascorbic Acid	1	0	1
Bain marie (1 h)	Thiamin	31	43	70
	Ascorbic Acid	0	0	4
Bain marie (2 h)	Thiamin	35	47	64
	Ascorbic Acid	0	0	2

*Calculated as percent of vitamin content in frozen starting material

**See Table 1 for details

F_o values for the processing of peas and carrots ranged 8.0-12.6 for TP, 6.1-9.4 for B Ration peas and 6.0-9.4 for B Ration carrots. Previously, Thomas, Narayan and Atwood tried to correlate F_o with thiamin content of TP and B Ration pork.[3] However, for five TP (F_o: 6.7-12.5) and five No. 10 B Ration (F_o: 12.6-15.3) pork, thiamin contents were the same within experimental error. The authors stated that the wide variation in F_o values is probably due to the difficulty of positioning thermocouples precisely at the slowest heating points of TP. Another important factor seems to be the high z value (48) for thiamin.[11] F_o values for thiamin destruction would not vary as greatly as those for an organism with z=18 during heat processing. In any case, no special attention was paid to the F_o value of each individual can.

Peas and carrots cooked using frozen starting material (A Ration) lost half as much thiamin as those retorted in TPs and B Ration cans (Tables 2 and 3). The major causes of loss are probably leaching and thermal degradation of thiamin during cooking and retorting. The thiamin contents of peas and carrots in TPs and No. 10 B Ration cans are not significantly different. In a previous study, thiamin retention of TP pork (32%) was shown to be much greater than that of No. 10 B Ration pork (7%) after retorting.[3] The difference between the two items may be explained on the basis of severity of heat treatment required for retorting to achieve similar F_o. Pork is heated mostly by conduction, while the brine in pea and carrot cans is heated by convection during retorting.

On the average, the pork in No. 10 B Ration cans is subjected to much more severe heat than that in flat TP containers due to the cylindrical shape. The cooking time for pork processed to comparable F_o was 40 min for TP and 230 min for No. 10 B Ration cans (M. H. Thomas, personal communication). However, peas and carrots in cylindrical and rectangular cans experience similar heat exposure since convective heating requires shorter process time. For the comparison of heat exposure during processing of peas and carrots, come-up time (time to bring retort water temperature to cooking temperature) must be included as well as cooking time. For TP peas and carrots (F_o: 8.0-12.6) come-up time was 40 min and cooking time was 6 min. They were 55 min and 2 min, respectively, for peas in No. 10 cans (F_o: 6.0-9.4) and 41 min and 6 min for carrots (F_o: 6.0-9.4).

Table 3 shows that the retention of ascorbic acid in cooked peas and carrots in A Ration (9%) is less than that in retorted TP (28%) and B Ration (32%). The result is in contrast with thiamin retention, which is higher for A Ration cooking (72%) than for T and B Ration retorting (43% and 42% respectively). Ascorbic acid is known to be highly sensitive to heat and oxygen. However, it can be stable when protected from air in cans and bottles (see A. E. Bender[12] and references therein). The loss of ascorbic acid in T, B and A Rations may thus be correlated with the amount of oxygen available during retorting and cooking of foods. Most oxygen available during retorting of vacuum sealed TPs and B Ration cans is from dissolved air, while oxygen is unlimited throughout cooking for A

Rations. The retention of ascorbic acid is similar in TP and B Ration peas and carrots, as for thiamin.

Effect of serving practice

Heating peas and carrots in TPs and holding them in insulated containers or bain maries reduces thiamin content only slightly as does heating them twice or three times (Table 2a). For samples heated and held in bain marie for 1 h, TP cans with higher F_o values may have been used, giving lower average thiamin content than those held for 2 h. If TP cans with various F_o values had been pooled for each treatment, the difference in thiamin content among samples may have been shown more clearly. In any case, the effect of military serving practice on thiamin content of TP peas and carrots is minimal.

For B Ration products (Table 2b), the military serving practices, including the heating process, hardly affect thiamin content of peas and carrots.

For A Ration product, cooking destroyed 28% of thiamin. The serving practice has a slight effect (Tables 2c and 3). In the worst case for A Ration when peas and carrots were cooked, held on the bain marie for 2 hours, refrigerated overnight and reheated, 50% thiamin was retained.

The loss of ascorbic acid is much greater than that of thiamin in peas and carrots after each treatment. As mentioned above, peas and carrots contained the impurity which coeluted with ascorbic acid under the HPLC condition used. The ascorbic acid data were corrected for the impurity. The retention of ascorbic acid is 9% in A Rations after cooking. Holding

A Ration peas and carrots in insulated containers or bain maries further decreases ascorbic acid content. When peas and carrots were held in bain maries or insulated containers for 2 h, little ascorbic acid remained.

For T and B Rations, approximately 30% ascorbic acid remains after retorting. After heating, almost all ascorbic acid is destroyed. In the B Ration, ascorbic acid destruction seems to take place rapidly during heating because peas and carrots are exposed to air. For TPs, heating is carried out unopened in simmering water. Ascorbic acid is probably destroyed when a TP is opened, drained and left in the freezer for cooling, since peas and carrots are hot and exposed to air during this period.

The results described above indicate that the T and B Ration peas and carrots are equivalent as far as the retention of the two most labile nutrients, thiamin and ascorbic acid, is concerned. T and B Rations are lower in these vitamins than the A Ration. Previously it was found that thiamin retention in pork was higher in T Ration than B Ration.[3] Both the T and B Rations were lower in thiamin than the A Ration. It may be concluded, therefore, that new T Ration products are nutritionally superior or at least equivalent to B Ration items, some of which are to be replaced by T Ration ones. Further studies on other classes of food (breakfast items, desserts, etc.) would be needed to support such a conclusion.

CONCLUSIONS

a. Ascorbic acid is less stable than thiamin under the processing and serving conditions studied. The retention of ascorbic acid is lower than that of thiamin in peas and carrots in T, B and A Rations.

b. Major loss of thiamin occurs during the retorting or cooking process. The serving practices have minimal effect on thiamin for all three rations.

c. Little ascorbic acid remains after retorting and heating of T and B Ration peas and carrots. Cooked peas and carrots (A Ration) still retain some ascorbic acid, which disappears rapidly upon holding.

d. The retention of thiamin in peas and carrots at the time of consumption is approximately the same for T and B Rations. They are lower in thiamin than A Rations. Almost no ascorbic acid remains in T and B Ration peas and carrots at the time of consumption. The A Ration contains some ascorbic acid depending on the point of consumption during the heating-serving cycle.

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